

# **BAYOU TIGRE TMDLS FOR DISSOLVED OXYGEN AND NUTRIENTS**

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BAYOU TIGRE TMDLS  
FOR DISSOLVED OXYGEN AND NUTRIENTS  
SUBSEGMENT 060903

Prepared for

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## **EXECUTIVE SUMMARY**

Section 303(d) of the Federal Clean Water Act requires states to identify waterbodies that are not meeting water quality standards and to develop total maximum daily pollutant loads for those waterbodies. A total maximum daily load (TMDL) is the amount of pollutant that a waterbody can assimilate without exceeding the established water quality standard for that pollutant. Through a TMDL, pollutant loads can be distributed or allocated to point sources and nonpoint sources (NPS) discharging to the waterbody. This report presents TMDLs that have been developed for dissolved oxygen (DO) and nutrients for Bayou Tigre (subsegment 060903), in the Vermilion-Teche basin in southern Louisiana.

Bayou Tigre is located east of Abbeville, Louisiana in an area where agriculture is the dominant land use. This stream is tidally influenced in the lower reaches due to its low gradient and proximity to the Gulf of Mexico. The largest point source discharge is the Town of Erath sewage treatment plant (STP).

Subsegment 060903 was listed on the Modified Court Ordered 303(d) List for Louisiana as not fully supporting the designated use of propagation of fish and wildlife and was ranked as priority #1 for TMDL development. This subsegment was not included on the 1998 303(d) List, but was later added to the list based on LDEQ assessment data collected during June through December 1998. The causes for impairment cited in the 303(d) List included organic enrichment/low DO and nutrients. The water quality standard for DO is 4 mg/L year round for the subsegment.

A water quality model (LA-QUAL) was set up to simulate DO, CBOD, ammonia nitrogen, organic nitrogen, and conductivity in the subsegment. The model was calibrated using data collected during FTN's synoptic survey in September 2000 and other various information obtained from LDEQ and USGS. There were no intensive survey data available for the subsegment. The projection simulation was run at critical flows and temperatures to address seasonality as required by the Clean Water Act. Reductions of existing loads from both point sources and NPS were required for the projection simulation to show the DO standard of 4 mg/L

being maintained. In general, the modeling in this study was consistent with guidance in the Louisiana TMDL Technical Procedures Manual.

A TMDL for oxygen demanding substances (CBOD, ammonia nitrogen, organic nitrogen, and sediment oxygen demand) was calculated using the results of the projection simulation. Both implicit and explicit margins of safety were included in the TMDL calculations. The nutrient TMDL was developed based on Louisiana's water quality standard for nutrients, which states that "the naturally occurring range of nitrogen to phosphorus ratios shall be maintained". The nutrient TMDL was calculated using allowable nitrogen loadings from the projection simulation and applying a naturally occurring nitrogen to phosphorus ratio to determine the allowable phosphorus loadings.

Each TMDL for this subsegment includes a wasteload allocation (WLA) for the Town of Erath STP plus an additional WLA for all of the other point sources with minor oxygen demanding discharges within the subsegment. In order to meet the DO standard of 4 mg/L throughout Bayou Tigre, a treatment upgrade will be required for the Town of Erath STP and NPS loads will need to be reduced by an average of 27%.

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## 1.0 INTRODUCTION

This report presents total maximum daily loads (TMDLs) for dissolved oxygen (DO) and nutrients for Bayou Tigre, subsegment 060903. This subsegment was listed on the February 29, 2000 Modified Court Ordered 303(d) List for Louisiana (EPA 2000) as not fully supporting the designated use of propagation of fish and wildlife. The subsegment was not included on the 1998 303(d) List (LDEQ 1998), but was later added to the list based on LDEQ assessment data collected during June through December 1998. The suspected sources and suspected causes for impairment in the 303(d) List are included in Table 1.1. Subsegment 060903 was ranked as priority #1 for TMDL development. The TMDLs in this report were developed in accordance with Section 303(d) of the Federal Clean Water Act and EPA's regulations at 40 CFR 130.7. The 303(d) Listings for other pollutants in this subsegment are being addressed by EPA and the Louisiana Department of Environmental Quality (LDEQ) in other documents.

The purpose of a TMDL is to determine the pollutant loading that a waterbody can assimilate without exceeding the water quality standard for that pollutant and to establish the load reduction that is necessary to meet the standard in a waterbody. The TMDL is the sum of the wasteload allocation (WLA), the load allocation (LA), and a margin of safety (MOS). The WLA is the load allocated to point sources of the pollutant of concern, and the LA is the load allocated to nonpoint sources (NPS). The MOS is a percentage of the TMDL that accounts for the uncertainty associated with the model assumptions, data inadequacies, and future growth.

Table 1.1. Summary of 303(d) Listing of subsegment 060903 (EPA 2000).

Subsegment Number	Waterbody Description	Suspected Sources	Suspected Causes	Priority Ranking (1 = highest)
060903	Bayou Tigre	Minor municipal point source Non-irrigated crop production Irrigated crop production Petroleum activities Septic tanks Minor industrial point sources Package plants (small flows) Municipal	Organic enrichment/low DO Suspended solids Turbidity Pesticides Nutrients	1



## 2.0 STUDY AREA DESCRIPTION

### 2.1 General Information

The Bayou Tigre subsegment is located east of Abbeville, Louisiana in the lower portion of the Vermilion-Teche basin in southern Louisiana (see map in Appendix A). The subsegment area is 36 mi<sup>2</sup>. The largest point source discharge is the Town of Erath sewage treatment plant (STP). The area contributing the freshwater inflow to Bayou Tigre is dominated by agriculture. Bayou Tigre extends approximately 2 miles beyond the eastern boundary of subsegment 060903 to its confluence with Bayou Carlin, which is tidally influenced. Therefore, Bayou Tigre receives freshwater from the northern overland drainage, and receives some saltwater intrusion via Bayou Carlin. Land use data for the study area is shown in Table 2.1.

Table 2.1. Land uses in subsegment 060903 based on GAP data (USGS 1998).

Land Use Type	% of Total Area
Fresh Marsh	0.5%
Saline Marsh	0.0%
Wetland Forest	1.7%
Upland Forest	1.3%
Wetland Scrub/Shrub	0.1%
Upland Scrub/Shrub	0.3%
Agricultural	82.3%
Urban	8.7%
Water	5.1%
Barren Land	0.0%
TOTAL	100.0%

### 2.2 Water Quality Standards

The numeric water quality standards and designated uses for this subsegment are shown in Table 2.2. The primary numeric standard for the TMDLs presented in this report is the DO standard of 4 mg/L year round. The DO standard for Bayou Tigre is based on its designation as an estuarine subsegment.

Table 2.2. Water quality standards and designated uses (LDEQ 2000a).

Subsegment Number	060903
Waterbody Description	Bayou Tigre
Designated Uses	ABC
Criteria:	
Chloride	N/A
Sulfate	N/A
DO	4 mg/L (year round)
pH	6.5-9.0
Temperature	35 °C
TDS	N/A

USES: A – primary contact recreation; B – secondary contact recreation; C – propagation of fish and wildlife; D – drinking water supply; E – oyster propagation; F – agriculture; G – outstanding natural resource water; L – limited aquatic life and wildlife use.

For nutrients, there are no specific numeric criteria, but there is a narrative standard that states “The naturally occurring range of nitrogen-phosphorus ratios shall be maintained.... Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters.” (LDEQ 2000a).

In addition, LDEQ issued a declaratory ruling on April 29, 1996, concerning this language and stated, “That DO directly correlates with overall nutrient impact is a well-established biological and ecological principle. Thus, when the LDEQ maintains and protects DO, the LDEQ is in effect also limiting and controlling nutrient concentrations and impacts.” DO serves as the indicator for the water quality criteria and for assessment of use support. For the TMDLs in this report, the nutrient loading required to maintain the DO standard is the nutrient TMDL.

## **2.3 Identification of Sources**

### **2.3.1 Point Sources**

A list of NPDES permits that were identified in or near the Bayou Tigre subsegment is included in Appendix B. These permits were identified by searching two sources of information. The primary source was a listing of all the permits in the Vermilion-Teche basin (basin

number 06) from the LDEQ static database. The secondary source was a listing of all the permits in the Vermilion-Teche basin (hydrologic units 08080102 and 08080103 from EPA's Permit Compliance System (PCS) on the EPA website. All of the information concerning permit parameters and design flow in Appendix B was obtained by manually retrieving hard copies of permit files from LDEQ's file room.

Facilities without oxygen demanding parameters in their permit were assumed to exert a negligible oxygen demand in the receiving stream; therefore, these facilities were excluded from any further consideration in these TMDLs. All of the facilities with oxygen demanding parameters in their permit were included in the TMDL calculations, but only one of them was considered large enough to be modeled explicitly. The remaining oxygen demanding discharges were included in the TMDL by adding their oxygen demand to the total loading simulated in the model.

The point source that was explicitly included in the model was the Town of Erath STP. The approximate location of this discharger is shown in Appendix A. The permit record, permit application, and Discharge Monitoring Reports (DMRs) for this facility were examined and appropriate input information for the calibration and projection modeling runs was derived to the maximum extent possible.

Relevant information for the discharge explicitly included in the model is listed below:

	<u>Town of Erath STP</u>
Permit number:	LA0054739
Receiving stream:	Tigre Coulee to Bayou Tigre
Design flow:	0.75 mgd
Permit limits:	10 mg/L BOD <sub>5</sub> (monthly avg.)
Treatment:	Extended aeration

### **2.3.2 Nonpoint Sources**

Several NPS were cited as suspected sources of impairment in the 303(d) List (Table 1.1). These NPS include non-irrigated crop production, irrigated crop production, petroleum activities, and septic tanks.

## **2.4 Previous Data and Studies**

Listed below are previous water quality data and studies in or near the subsegment in the study area. The locations of the LDEQ ambient monitoring stations are shown in Appendix A.

1. Twice monthly data collected by LDEQ for “Bayou Tigre south of Delcambre, Louisiana” (station 0682) for mid-June to December 1998.
2. Data collected by LDEQ on Delcambre Canal east of Abbeville, LA (Station 0315) for January 1991 to June 1998 (bi-monthly) and June to December 1998 (twice per month).

### **3.0 CALIBRATION OF WATER QUALITY MODEL**

#### **3.1 Model Setup**

In order to evaluate the linkage between pollutant sources and water quality, a computer simulation model was used. The model used for these TMDLs was LA-QUAL (version 3.02), which was selected because it includes the relevant physical, chemical, and biological processes and it has been used successfully in the past for other TMDLs in Louisiana. The LA-QUAL model was set up to simulate organic nitrogen, ammonia nitrogen, ultimate carbonaceous biochemical oxygen demand (CBOD<sub>u</sub>), conductivity, and DO. Phosphorus and algae were not simulated because algae do not appear to have significant impacts on DO in this subsegment.

A vector diagram of the model is shown in Appendix C. The vector diagram shows the reach/element design and the location of the modeled inflows and point sources. Bayou Tigre was divided into four reaches to represent varying depths and widths along the stream. Reaches 1 and 2 were divided into smaller elements because there will likely be some variation in water quality along their length due to the point source discharge. Based on uniformity of hydraulics and water quality, reaches 3 and 4 were each represented as one element.

#### **3.2 Calibration Period**

An intensive field survey was not performed for the study area due to schedule and budget limitations. A synoptic survey of the study area was performed by FTN in September 2000, and data were collected at two stations (682-2 and 682-1) on Bayou Tigre shown on the map in Appendix A. The only historical period for which water quality data were collected for the subsegment was the June through December 1998 period when LDEQ collected their assessment data at station 0682 (station 682-1 during FTN synoptic survey). The water quality data from the FTN synoptic survey and from LDEQ's historical ambient monitoring are summarized in Appendix D.

Based on the synoptic survey, the DO in Bayou Tigre appears to exhibit some differences between the upper and lower ends of the stream. For simulating longitudinal gradients in water

quality, the September 2000 synoptic survey was considered to be a better calibration data set than the LDEQ historical data set. The calibration targets (i.e., the concentrations to which the model was calibrated) for each parameter at the two stations were set to the concentrations measured during the FTN synoptic survey in September 2000.

### **3.3 Temperature Correction of Kinetics (Data Type 4)**

The temperature correction factors used in the model were consistent with the Louisiana Technical Procedures Manual (the “LTP”; LDEQ 2000b). These correction factors were:

- Correction for BOD decay: 1.047 (value in LTP is same as model default)
- Correction for SOD: 1.065 (value in LTP is same as model default)
- Correction for ammonia N decay: 1.070 (specified in Data Group 4)
- Correction for organic N decay: 1.020 (not specified in LTP; model default used)
- Correction for reaeration: automatically calculated by the model

### **3.4 Hydraulics and Dispersion (Data Types 9 and 10)**

The hydraulics were specified in the input for the LA-QUAL model using the power functions ( $\text{width} = a * Q^b + c$  and  $\text{depth} = d * Q^e + f$ ). Widths and depths were estimated primarily from digital ortho-quarter quad maps (see Appendix E). Under low flow conditions, the depths and widths for reaches 2 through 4 in the model were assumed to be independent of flow rate because of tidal backwater. Therefore, the system was modeled with constant depth and width. This was specified in the model by setting the coefficients and exponents for reaches 2 through 4 as:

- width coefficient (a) = width
- width exponent (b) = 0.0
- width constant (c) = 0.0
- depth coefficient (d) = depth
- depth exponent (e) = 0.0
- depth constant (f) = 0.0

Reach 1 was assumed to be outside the influence of tides and the width and depth was assumed to vary with flow. Default width and depth exponents of 0.12 and 0.45 (Leopold et al.

1964), respectively, were used to calculate width and depth coefficients for reach 1 based on the estimated flow in the reach. Values input for each reach are shown in Appendix E.

Tidal dispersion was accounted for in reaches 2 through 4 by specifying dispersion coefficients in data type 10 of the model input. The dispersion coefficient for reach 4 was set to  $2.97 \text{ m}^2/\text{sec}$  ( $32 \text{ ft}^2/\text{sec}$ ), which is the same value used in the Limno-Tech waste load allocation for the Commercial Canal near New Iberia (Limno-Tech 1984). The dispersion coefficient was reduced linearly in each upstream reach to a value of  $0.0 \text{ m}^2/\text{sec}$  at the headwater.

### **3.5 Initial Conditions (Data Type 11)**

The primary parameter that is specified in the initial conditions for LA-QUAL is the temperature for each reach (because temperature was not being simulated). The temperature for each reach was set to  $28^\circ\text{C}$ , the measured value at stations 682-1 and 682-2 during the calibration period. The input data and sources are shown in Appendix E.

One other parameter that was specified in the initial conditions was the salinity. Salinity was not simulated in the model (i.e., it was not “turned on” in Data Group 2), but a salinity value was entered as an initial condition so the model would use that value in the calculations for DO saturation. Because salinity data were not available for this subsegment, salinity values were estimated based on the conductivity measurements from the FTN synoptic survey and a conversion between conductivity and salinity (equation 3-9b in EPA 1985).

For constituents not being simulated, the initial concentrations were set to zero; otherwise, the model would have assumed a fixed concentration of those constituents and the model would have included the effects of the unmodeled constituents on the modeled constituents (e.g., the effects of algae on DO).

### **3.6 Water Quality Kinetics (Data Types 12 and 13)**

Kinetic rates used in LA-QUAL include reaeration rates, SOD, CBOD decay rates, nitrification rates, and mineralization rates (organic nitrogen decay). The values used in the model input are shown in Appendix E.

The Louisiana Equation (option 15) was specified for reaeration in reaches 1 and 2 of the model. Reaches 3 and 4, where surface widths are greater than 30 m, were considered wide enough that wind-aided reaeration might be significant. For reaeration in these reaches, the surface transfer coefficient ( $K_L$ ) was specified (option 20 in the model). A wind-aided surface transfer coefficient was calculated using the same methodology as used in the Mermentau River model (LDEQ 1999) and in the Lake Fausse Pointe/Dauterive Lake model (FTN 2000b). Daily wind speeds from the cities of Lake Charles and New Orleans were averaged over the calibration period, corrected to a height of 0.1 m, and then used to calculate a wind-aided surface transfer coefficient of 0.99 m/day for both reaches.

The SOD rates were developed through iteration in the calibration. The SOD rate for each reach was adjusted so that predicted DO concentrations were similar to the calibration target values.

The CBOD decay rate was set to 0.10/day which is the default value that LDEQ provided in its guidance for uncalibrated modeling of the Mermentau and Vermilion-Teche basins (LDEQ 2000c) and information in “Rates, Constants, and Kinetics Formulations in Surface Water Modeling” (EPA 1985).

Mineralization rates (organic nitrogen decay) in the model were set to 0.02/day for all reaches. This value was based on information in the “Rates, Constants, and Kinetics” publication (EPA 1985). Nitrification rates were set to 0.10/day for all reaches, which is consistent with guidance in the LTP based on stream depth. The combination of these rates is consistent with LDEQ’s guidance for uncalibrated modeling of the Mermentau and Vermilion-Teche basins (LDEQ 2000c). The LDEQ guidance specified a default rate of 0.05/day for nitrogenous biochemical oxygen demand (NBOD) decay, which represents the combination of mineralization and nitrification.

One other input value was specified for characterizing the nitrification process. In the program constants section of the model input file (data type 3), the nitrification inhibition option was set to 1 instead of the default of option number 2. With the default option, the nitrification rate drops rapidly when the DO drops below 2 mg/L, which results in an unrealistic build up of ammonia nitrogen at low DO. Option number 1 provides nitrification inhibition that is similar to

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what is used in other water quality models such as QUAL2E and WASP (see Figure 3.5 in FTN 2000a).

### **3.7 Nonpoint Source Loads (Data Type 19)**

The NPS loads that are specified in the model can be most easily understood as resuspended load from the bottom sediments and are modeled as SOD, benthic ammonia source rates, CBOD loads, and organic nitrogen loads. The SOD (specified in data type 12), the benthic ammonia source rates (specified in data type 13), and the mass loads of organic nitrogen and CBODu (specified in data type 19) were all treated as calibration parameters; their values were adjusted until the model output was similar to the calibration target values. The values used as model input are shown in Appendix E.

These four calibration parameters were adjusted in a specific order based on the interactions between state variables in the model. First, the organic nitrogen loads were adjusted until the predicted organic nitrogen concentrations were similar to the observed concentrations. Organic nitrogen was calibrated first because none of the other state variables affect the organic nitrogen concentrations. Next, the benthic ammonia source rates were adjusted until the predicted ammonia nitrogen concentrations were similar to the observed concentrations. Then the CBODu loads were adjusted until the predicted CBODu concentrations were similar to the observed concentrations. Finally, the SOD rates were adjusted until the predicted DO concentrations were similar to the observed concentrations. The DO was calibrated last because all of the other state variables affect DO.

### **3.8 Headwater Flow Rate (Data Type 20)**

The headwater inflow rate was based on USGS measured flows for Bayou des Cannes at Eunice (08010000) during the calibration period (September 20, 2000). This was the closest USGS gage with flow data available during the calibration period. Precipitation stations in the vicinity of Bayou des Cannes and Bayou Tigre did not record significant rainfall events immediately prior to this period. Based on the estimated flow per square mile of drainage area at Bayou des Cannes, a flow at the downstream end of the subsegment was calculated using the

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total drainage area of the subsegment. Because the calculated flow at the downstream end of the subsegment was so low ( $0.0013 \text{ m}^3/\text{sec}$ ), this flow was input as the headwater flow and assumed to be constant for all reaches in the model (i.e., no incremental inflows were added).

### 3.9 Headwater Water Quality (Data Types 20 and 21)

Concentrations of DO, CBOD<sub>u</sub>, organic nitrogen, and ammonia nitrogen were specified in the model for the headwater inflow. Headwater quality was based on the average of concentrations measured at stations representing inflows from agricultural areas during FTN's synoptic survey in September 2000. The stations used to develop these water quality concentrations include the following:

FTN Station Number	Waterbody Name
649-3	Bayou Doza (flows into Bayou Mallet)
649-4	Bayou Mallet (upper)
658-2	Middle Bayou Grand Marais (lower)
658-3	West Bayou Grand Marais (upper)
681-3	Seguna Br Canal (flows into Bayou Petite Anse)
681-4	Almenco Br Canal (flows into Bayou Petite Anse)
683-2	Rodere Canal (flows into New Iberia S. Drng Canal)
683-3	Peebles Coulee (flows into New Iberia S. Drng Canal)

The FTN monitoring data included DO, total Kjeldahl nitrogen (TKN), CBOD<sub>5</sub>, conductivity, and ammonia nitrogen. The median ratio of CBOD<sub>u</sub> to CBOD<sub>5</sub> from the LDEQ long term BOD analyses during 2000 was 4.5 and this relationship was used to estimate CBOD<sub>u</sub> from the average CBOD<sub>5</sub> observed at the above stations. Organic nitrogen was estimated as the average TKN value measured at the above stations minus the average ammonia nitrogen concentration measured at the above stations. The values used as model input are shown in Appendix E.

### **3.10 Point Source Inputs (Data Types 24 and 25)**

Flows and CBOD<sub>u</sub> concentrations for the Town of Erath STP were based on the values on the discharge monitoring report (DMR) for September 2000. The CBOD<sub>u</sub> value used for model input was obtained by multiplying the BOD<sub>5</sub> value from the DMR by an assumed CBOD<sub>u</sub>:BOD<sub>5</sub> ratio of 2.3 (which is consistent with the LTP). For parameters not reported on the DMR, concentrations were based on typical wastewater values. The values used as model input are shown in Appendix E.

### **3.11 Lower Boundary Conditions (Data Type 27)**

Because longitudinal dispersion was explicitly specified in data type 10, the model required input values for downstream boundary conditions. Water quality parameters input for the downstream boundary were based on measurements at the LDEQ station at Delcambre Canal east of Abbeville, Louisiana (station 0315). The LDEQ ambient monitoring data included DO, total organic carbon (TOC), and TKN, but not CBOD or ammonia nitrogen. The DO value used was the average value measured during August and September 1998. TOC was not measured at this station during August and September 1998, so the CBOD<sub>u</sub> value used for downstream boundary water quality was based on the average TOC measurement from October through December 1998. Relationships between TOC and CBOD<sub>u</sub> were developed using data from the FTN synoptic survey in September 2000 and data from LDEQ's long term BOD analyses during 2000. The median ratio of TOC to CBOD<sub>5</sub> from the FTN synoptic survey data was 6.0 and the median ratio of CBOD<sub>u</sub> to CBOD<sub>5</sub> from the LDEQ long term BOD data was 4.5. Combining these ratios yielded the following relationship that was used to develop model input:

$$\text{CBOD}_u = 0.75 * \text{TOC}$$

The average TKN concentration at the Delcambre station from August and September 1998 was used to estimate ammonia and organic nitrogen values for the downstream boundary. The median ratio of ammonia nitrogen to TKN from the FTN synoptic survey data was 0.17. This value was similar to the median ratio of ammonia nitrogen to TKN from the LDEQ data.

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The organic nitrogen was then determined as TKN minus ammonia nitrogen. This yielded the following relationships that were used to develop the model input:

$$\text{Ammonia nitrogen} = 0.17 * \text{TKN}$$

$$\text{Organic nitrogen} = 0.83 * \text{TKN}$$

Temperature and salinity for the downstream boundary were set to the same values as in the last reach of the model (so that the model would not change the values specified for the last reach). The values used as model input are shown in Appendix E.

### **3.12 Model Results for Calibration**

Plots of predicted and observed water quality for the calibration are presented in Appendix F and a printout of the LA-QUAL output file is included as Appendix G. The calibration was considered to be acceptable based on the amount of data that were available.

## **4.0 WATER QUALITY MODEL PROJECTION**

EPA's regulations at 40 CFR 130.7 require the determination of TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. Therefore, the calibrated model was used to project water quality for critical conditions. The identification of critical conditions and the model input data used for critical conditions are discussed below.

### **4.1 Identification of Critical Conditions**

Section 303(d) of the Federal Clean Water Act and EPA's regulations at 40 CFR 130.7 both require the consideration of seasonal variation of conditions affecting the constituent of concern and the inclusion of a MOS in the development of a TMDL. For the TMDLs in this report, analyses of LDEQ long-term ambient data were used to determine critical seasonal conditions. A combination of implicit and explicit MOS was used in developing the projection model.

Critical conditions for DO have been determined for the Vermilion-Teche basin in previous TMDL studies. The analyses concluded that the critical conditions for stream DO concentrations occur during periods with negligible nonpoint runoff, low stream flow, and high stream temperature.

When the rainfall runoff (and nonpoint loading) and stream flow are high, turbulence is higher due to the higher flow and the stream temperature is lowered by the cooler precipitation and runoff. In addition, runoff coefficients are higher in cooler weather due to reduced evaporation and evapotranspiration, so that the high flow periods of the year tend to be the cooler periods. DO saturation values are, of course, much higher when water temperatures are cooler, but BOD decay rates are much lower. For these reasons, periods of high loading are periods of higher reaeration and DO but not necessarily periods of high BOD decay.

LDEQ interprets this phenomenon in its TMDL modeling by assuming that the annual nonpoint loading, rather than loading for any particular day, is responsible for the accumulated benthic blanket of the stream, which is, in turn, expressed as SOD and/or resuspended BOD in

the model. This accumulated loading has its greatest impact on the stream during periods of higher temperature and lower flow.

According to the LTP, critical summer conditions in DO TMDL projection modeling are simulated by using the annual 7Q10 flow or 0.1 cfs, whichever is higher, for all headwaters, and 90th percentile temperature for the summer season. Model loading is from point sources, perennial tributaries, SOD, and resuspension of sediments. In addition, all point sources are assumed to be discharging at design capacity.

In reality, the highest temperatures occur in July-August, the lowest stream flows occur in October-November, and the maximum point source discharge occurs following a significant rainfall, i.e., high-flow conditions. The combination of these conditions plus the impact of other conservative assumptions regarding rates and loadings yields an implicit MOS that is not quantified. Over and above this implicit MOS, an explicit MOS of 20% for point sources and 10% for NPS was incorporated into the TMDLs in this report to account for future growth and model uncertainty.

## **4.2 Temperature Inputs**

The LTP (LDEQ 2000b) specified that the critical temperature should be determined by calculating the 90th percentile seasonal temperature for the waterbody being modeled. Because the LDEQ station for Bayou Tigre has only 6 months of data, LDEQ data from another subsegment were used for this analysis. Long term temperature data from Delcambre Canal east of Abbeville (LDEQ station 0315) were used to calculate a 90<sup>th</sup> percentile summer temperature of 31.0°C. However, the water temperatures for the Bayou Tigre station during June through December 1998 were slightly warmer (0.2°C) than the temperatures in Delcambre Canal during that time. This difference was added to the 90<sup>th</sup> percentile summer temperature for Delcambre to yield a critical temperature of 31.2°C for Bayou Tigre. This value was specified in Data Type 11 in the model and is shown in Appendix H.

Because Bayou Tigre has a year round standard for DO, a winter projection simulation was not performed. As discussed above, the most critical time of year for meeting a constant DO standard is the period of high temperatures and low flows (i.e., summer).

### **4.3 Headwater Inputs**

The inputs for the headwaters and tributaries for the projection simulation were based on guidance in the LTP as well as output from projection models of upstream waterbodies (in previously completed TMDLs). As specified in the LTP, the DO concentration for the headwater inflow was set to 90% saturation at the critical temperature. Headwater concentrations for other parameters were set to calibration values.

There are no USGS flow gages and no published 7Q10 flows for the inflow to Bayou Tigre. However, published 7Q10 values were available for the USGS gages for Bayou Bourbeau at Shuteston (07386500) and Bayou Carencro at Sunset (07386000). Both of these gages are in the Vermilion River basin and have a small drainage area where most of the flow is natural runoff rather than water that has been diverted from another basin. The published 7Q10 flow is zero for both of these gages (USGS 1980). Because the drainage areas for these gages (19 mi<sup>2</sup> for Bayou Bourbeau and 37 mi<sup>2</sup> for Bayou Carencro) are larger than the drainage area for the headwater inflow to Bayou Tigre (approximately 3.5 mi<sup>2</sup>), the 7Q10 flow for the headwater was assumed to be zero. The LTP specifies that the critical flow rate for summer should be set to the 7Q10 flow or 0.1 cfs, whichever is smaller. Therefore, the headwater flow rate in the projection simulation was set to 0.1 cfs (0.003 m<sup>3</sup>/sec). The values used as model input in the projection simulation are shown in Appendix H.

### **4.4 Point Source Inputs**

For the Town of Erath STP, the flow was set to 125% of the design flow in order to incorporate an explicit margin of safety for the point source wasteload allocation. CBOD<sub>u</sub> was initially set to 2.3 times the current BOD<sub>5</sub> permit limit of 10 mg/L. There is currently no ammonia limit for the facility. Even with a 99% reduction in NPS loads and SOD in reach 1 and the point source ammonia concentration set at 5 mg/L, the initial projection simulations were showing DO values below the 4.0 mg/L standard in the upper two reaches. Therefore, the concentrations for the Erath STP discharge were set assuming an upgrade in the level of treatment. It was assumed that the treatment would be upgraded to meet a BOD<sub>5</sub> concentration of

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5 mg/L and an ammonia nitrogen concentration of 2 mg/L. The organic nitrogen concentration was set at half of the ammonia nitrogen concentration and the effluent DO concentration was set to 5 mg/L (a typical value for advanced treatment). Other parameters without permit limits (i.e., nitrate-nitrite) were unchanged from the calibration values. The values used as model input in the projection simulation are shown in Appendix H.

#### **4.5 Nonpoint Source Loads**

Because the initial projection simulation was showing low DO values in all of the reaches, the NPS loadings were reduced until all of the predicted DO values were equal to or greater than the water quality standard of 4.0 mg/L. Within each reach, the same percent reduction was applied to all components of the NPS loads (SOD, benthic ammonia source rates, and mass loads of CBODu and ammonia nitrogen). The values used as model input in the projection simulation are shown in Appendix H.

#### **4.6 Downstream Boundary**

For the projection simulation, the downstream boundary condition for temperature was set to the critical temperature for Bayou Tigre. For DO, the downstream boundary condition was set to 4.0 mg/L, which is the water quality standard for Bayou Tigre and for the downstream subsegment (Bayou Carlin). The values used as model input in the projection simulation are shown in Appendix H.

#### **4.7 Other Inputs**

The only model inputs that were changed from the calibration to the projection simulation were the inputs discussed above in Sections 4.2 – 4.6. Other model inputs (e.g., hydraulic and dispersion coefficients, decay rates, reaeration rates, etc.) were unchanged from the calibration simulation.



#### **4.8 Model Results for Projection**

Plots of predicted water quality for the projection are presented in Appendix I and a printout of the LA-QUAL output file is included as Appendix J.

An average NPS load reduction of approximately 27% for all reaches, in addition to the treatment upgrade for the Town of Erath STP, were required to bring the predicted DO values to at least 4.0 mg/L. Required NPS load reductions were higher in reaches 1 and 2 (approximately 40% to 60%) immediately downstream of the STP.

The percentage reductions for NPS loads mentioned above represent percentages of the entire NPS loading, not percentages of the manmade NPS loading. The NPS loads in this report were not divided between natural and manmade because it would be difficult to estimate natural NPS loads for the study area.

## 5.0 TMDL CALCULATIONS

### 5.1 DO TMDL

A total maximum daily load (TMDL) for DO has been calculated for the Bayou Tigre subsegment based on the results of the projection simulation. The DO TMDLs are presented as oxygen demand from CBOD<sub>u</sub>, organic nitrogen, ammonia nitrogen, and SOD. A summary of the loads for Bayou Tigre is presented in Table 5.1. TMDL calculations are included in Appendix K.

Table 5.1. DO TMDL for Subsegment 060903 (Bayou Tigre).

	Oxygen demand (kg/day) from:				Total oxygen demand (kg/day)
	CBOD <sub>u</sub>	Organic N	Ammonia N	SOD	
WLA for Town of Erath STP	33	12	25	NA	70
WLA for minor point sources	5	NA	4	NA	9
MOS for all point sources	9	3	7	NA	19
LA for other NPS	514	9	0	441	964
MOS for all NPS	57	1	0	49	107
Total maximum daily load	618	25	36	490	1169

The oxygen demand from organic nitrogen and ammonia nitrogen was calculated as 4.33 times the nitrogen loads (assuming that all organic nitrogen is eventually converted to ammonia). The value of 4.33 is the same ratio of oxygen demand to nitrogen that is used by the LA-QUAL model. For the SOD loads, a temperature correction factor was included in the calculations (in order to be consistent with LDEQ procedures).

The WLAs for minor point sources represent the loads from small oxygen demanding discharges that were not explicitly modeled. In general, these WLAs were based on current permit limits with no reductions. For discharges with no available flow information, a design flow of 0.001 MGD was assumed. For discharges with no permit limits for ammonia nitrogen, effluent concentrations for ammonia nitrogen were assumed based on the BOD<sub>5</sub> permit limits and typical combinations of BOD<sub>5</sub> and ammonia nitrogen listed in the LTP (LDEQ 2000b).

Because the WLAs for minor point sources represented loads that were not simulated in the model, these loads were added to the total load that was simulated in the model. The explicit MOS for NPS was set to 10% of the NPS load simulated in the model. The explicit MOS for point sources was set to 20% of the total point source loading.

## 5.2 Nutrient TMDL

As discussed in Section 2.2, Louisiana has no numeric standards for nutrients, but has a narrative standard that states that “the naturally occurring range of nitrogen-phosphorus ratios shall be maintained” (LDEQ 2000a). For these TMDLs, nutrients were defined as total inorganic nitrogen (ammonia nitrogen plus nitrate/nitrite nitrogen) and total phosphorus. The value used for the naturally occurring nitrogen to phosphorus ratio was 1.96, which was the median ratio of total inorganic nitrogen to total phosphorus from historical data that was analyzed for a previous nutrient TMDL for the Lake Fausse Pointe/Dauterive Lake system (FTN 2000b).

The first step in calculating the nutrient TMDL was to determine the loads of total inorganic nitrogen (ammonia and nitrate-nitrite) that were simulated in the projection model. The loads in the projection model represent the maximum allowable loads that will maintain DO standards. Then the allowable loads of total phosphorus (TP) were calculated by dividing the nitrogen loads by the naturally occurring ratio of TIN to TP (which was 1.96 as discussed above). The resulting loads of TIN and TP for the Bayou Tigre subsegment are presented in Table 5.2.

Table 5.2. Nutrient TMDL for Subsegment 060903 (Bayou Tigre).

	<b>Total Inorganic Nitrogen (kg/day)</b>	<b>Nitrate N (kg/day)</b>	<b>Total Phosphorus (kg/day)</b>
WLA for Town of Erath STP	5.7	28.3	17.4
WLA for minor point sources	1.0	NA	0.5
MOS for all point sources	1.7	7.1	4.5
LA for other NPS	0.1	0.1	0.1
MOS for all NPS	0.0	0.0	0.0
Total Maximum Daily Load	8.5	35.5	22.5

## 5.3 Summary of NPS Reductions and Point Source Upgrades

In summary, the projection modeling used to develop the TMDLs above showed that NPS loads need to be reduced by an average of approximately 27% along all reaches of Bayou Tigre

to maintain the DO standard. NPS load reductions higher than the average (approximately 40% to 60%) would be required in the upper two reaches.

The projection model also showed that a treatment upgrade would be required for the Town of Erath STP. The effluent concentrations assumed for this discharge were:

Town of Erath STP: 5 mg/L CBOD<sub>5</sub>, 2 mg/L ammonia nitrogen, 5 mg/L DO

#### **5.4 Seasonal Variation**

As discussed in Section 4.1, critical conditions for DO in Louisiana waterbodies have been determined to be when there is negligible nonpoint runoff and low stream flow combined with high water temperatures. In addition, the models account for loadings that occur at higher flows by modeling sediment oxygen demand. Oxygen demanding pollutants that enter the waterbodies during higher flows settle to the bottom and then exert the greatest oxygen demand during the high temperature seasons.

#### **5.5 Margin of Safety**

The MOS accounts for any lack of knowledge or uncertainty concerning the relationship between load allocations and water quality. As discussed in Section 4.1, the highest temperatures occur in July through August, the lowest stream flows occur in October through November, and the maximum point source discharge occurs following a significant rainfall, i.e., high-flow conditions. The combination of these conditions, in addition to other conservative assumptions regarding rates and loadings, yields an implicit MOS which is not quantified. In addition to the implicit MOS, the TMDLs in this report included explicit MOS of 20% for point source loads and 10% for NPS loads.

## 6.0 SENSITIVITY ANALYSES

All modeling studies necessarily involve uncertainty and some degree of approximation. It is therefore of value to consider the sensitivity of the model output to changes in model coefficients, and in the hypothesized relationships among the parameters of the model. The sensitivity analyses were performed by allowing the LA-QUAL model to vary one input parameter at a time while holding all other parameters to their original value. The projection simulation was used as the baseline for the sensitivity analysis. The percent change of the model's minimum DO projections to each parameter is presented in Table 6.1. Each parameter was varied by  $\pm 30\%$ , except for temperature, which was varied  $\pm 2^\circ\text{C}$ .

Values reported in Table 6.1 are sorted by percentage variation of minimum DO from smallest percentage variation to largest. Reaeration was the parameter to which DO was most sensitive (14% to 32%). The other parameters causing the greatest variations in the minimum DO values were SOD (3% to 14%), temperature (6% to 10%), velocity (6% to 7%), and depth (3% to 8%). The model results were slightly sensitive to wasteload flow and BOD concentration and BOD decay rates with variations in predicted DO ranging from  $<1\%$  to 5%. The model was not sensitive to headwater flow, ammonia and organic nitrogen decay rates, or dispersion.

Table 6.1. Summary of results of sensitivity analyses.

<b>Input Parameter</b>	<b>Parameter Change</b>	<b>Predicted minimum DO (mg/L)</b>	<b>Percent Change in Predicted DO (%)</b>
Baseline	-	4.01	N/A
BOD decay rate	-30%	4.04	<1
Dispersion	+30%	4.01	<1
Dispersion	-30%	4.01	<1
Headwater flow	+30%	4.00	<1
Headwater flow	-30%	4.01	<1
NH <sub>3</sub> decay rate	+30%	3.98	<1
NH <sub>3</sub> decay rate	-30%	4.04	<1
Organic N decay rate	+30%	3.99	<1
Organic N decay rate	-30%	4.03	<1
Waste Load BOD	-30%	4.01	<1
Waste Load DO	+30%	4.01	<1
Waste Load flow	-30%	4.00	<1
Waste Load NH <sub>3</sub>	-30%	4.01	<1
Waste Load Organic N	+30%	3.99	<1
Waste Load Organic N	-30%	4.01	<1
Waste Load DO	-30%	3.96	1
Depth	-30%	4.14	3
Waste Load NH <sub>3</sub>	+30%	3.87	3
SOD	-30%	4.15	3
Waste Load BOD	+30%	3.84	4
Waste Load flow	+30%	3.84	4
BOD decay rate	+30%	3.82	5
Velocity	-30%	4.24	6
Initial Temperature	-2 °C	4.26	6
Velocity	+30%	3.74	7
Depth	+30%	3.69	8
Initial Temperature	+2 °C	3.62	10
SOD	+30%	3.46	14
Reaeration	+30%	4.58	14
Reaeration	-30%	2.71	32

## **7.0 OTHER RELEVANT INFORMATION**

This TMDL has been developed to be consistent with the antidegradation policy in the LDEQ water quality standards (LAC 33:IX.1109.A).

Although not required by this TMDL, LDEQ utilizes funds under Section 106 of the federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act to operate an established program for monitoring the quality of the state's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for water quality trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (Water Quality Inventory) and the 303(d) List of impaired waters. This information is also utilized in establishing priorities for the LDEQ NPS program.

The LDEQ has implemented a watershed approach to surface water quality monitoring. Through this approach, the entire state is sampled over a five-year cycle with two targeted basins sampled each year. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the five-year cycle. Sampling is conducted on a monthly basis or more frequently if necessary to yield at least 12 samples per site each year. Sampling sites are located where they are considered to be representative of the waterbody. Under the current monitoring schedule, targeted basins follow the TMDL priorities. In this manner, the first TMDLs will have been implemented by the time the first priority basins will be monitored again in the second five-year cycle. This will allow the LDEQ to determine whether there has been any improvement in water quality following establishment of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the 303(d) List. The sampling schedule for the first five-year cycle is shown below. The Mermentau River and Vermilion-Teche Basins will be sampled again in 2003.

1998 – Mermentau and Vermilion-Teche River Basins  
1999 – Calcasieu and Ouachita River Basins  
2000 – Barataria and Terrebonne Basins  
2001 – Lake Pontchartrain Basin and Pearl River Basin  
2002 – Red and Sabine River Basins

(Atchafalaya and Mississippi Rivers will be sampled continuously.)

In addition to ambient water quality sampling in the priority basins, the LDEQ has increased compliance monitoring in those basins, following the same schedule. Approximately 1,000 to 1,100 permitted facilities in the priority basins were targeted for inspections. The goal set by LDEQ was to inspect all of those facilities on the list and to sample 1/3 of the minors and 1/3 of the majors. During 1998, 476 compliance evaluation inspections and 165 compliance sampling inspections were conducted throughout the Mermentau and Vermilion-Teche River Basins.



## **8.0 PUBLIC PARTICIPATION**

When EPA establishes a TMDL, 40 CFR §130.7(d)(2) requires EPA to publicly notice and seek comment concerning the TMDL. Pursuant to an October 1, 1999 Court Order, this TMDL was prepared under contract to EPA. After submission of this TMDL to the Court, EPA commenced preparation of a notice seeking comments, information, and data from the general and affected public. Comments and additional information were submitted during the public comment period and this Court Ordered TMDL was revised accordingly. Responses to these comments and additional information are included in Appendix L. EPA has transmitted this revised TMDL to the Court and to LDEQ for incorporation into LDEQ's current water quality management plan.

## 9.0 REFERENCES

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- EPA. 2000. Modified Court Ordered 303(d) List for Louisiana. Downloaded from EPA Region 6 website ([www.epa.gov/earth1r6/6wq/ecopro/latmdl/modifiedcourtdorderedlist.xls](http://www.epa.gov/earth1r6/6wq/ecopro/latmdl/modifiedcourtdorderedlist.xls)).
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**APPENDICES A THROUGH K ARE  
AVAILABLE FROM EPA UPON REQUEST**

# **APPENDIX L**

## **Responses to Comments**

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COMMENTS AND RESPONSES  
BAYOU TIGRE  
TMDLs FOR DO AND NUTRIENTS  
April 19, 2002

EPA appreciates all comments concerning these TMDLs. Comments that were received are shown below with EPA responses inserted in a different font.

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GENERAL COMMENTS FROM LOUISIANA DEPARTMENT OF ENVIRONMENTAL QUALITY (LDEQ) (some of these comments may not apply to this report):

In view of LDEQ's TMDL development schedule and the rapidly approaching deadline, LDEQ has made a limited review of the TMDLs published by EPA on October 15, 2001. LDEQ expects to make a more detailed review on at least some of these TMDLs after the first of the year. In the future, LDEQ requests that EPA provide hard copies of the TMDLs and Appendices for LDEQ review. Several electronic files required software which is not used by LDEQ thus making it impossible to review some portions of several TMDLs. Hard copies will insure that the complete official document is being reviewed and will eliminate the time required for LDEQ to try to put together the document from electronic files. In general, LDEQ found these TMDLs to be unacceptable, based on inadequate data and not implementable.

**Federal Register Notice: Volume 66, Number 199, pages 52403 - 52404 (10/15/2001)**

- A. Vermilion River Cutoff DO and Nutrients .pdf
- B. Bayou Chene DO .pdf
- C. Bayou du Portage DO .pdf
- D. Bayou Mallet DO, Nutrients and Ammonia .pdf
- E. Bayou Petite Anse DO and Nutrients .pdf
- F. Bayou Tigre DO and Nutrients .pdf
- G. Big Constance Lake and Mermentau Coastal Bays and Gulf Water TMDLs for DO and Nutrients .pdf
- H. Charenton Drainage and Navigation Canal and West Cote Blanche Bay TMDLs for DO and Nutrients.pdf
- I. Chatlin Lake Canal/Bayou Du Lac and Bayou Des Glaisses Diversion Channel TMDLs for DO and Nutrients.pdf
- J. Dugas Canal DO and Nutrients .pdf
- K. Franklin Canal DO and Nutrients .pdf
- L. Freshwater Bayou Canal DO and Nutrients .pdf
- M. Irish Ditch/Big Bayou DO .pdf

- N. Lake Arthur, Grand Lake, and Gulf Intracoastal Waterway TMDLs for DO, Nutrients, and Ammonia .pdf
- O. Lake Peigneur DO and Nutrients .pdf
- P. New Iberia Southern Drainage Canal DO and Nutrients .pdf
- Q. Spanish Lake DO .pdf
- R. Tete Bayou DO and Nutrients .pdf
- S. Bayou Carron DO and Nutrients .pdf
- T. West Atchafalaya Basin Protection Levee Borrow Pit Canal DO.pdf

1. Many of these TMDLs are based on models using historical water quality data gathered at a single location rather than survey data gathered at several sites spaced throughout the waterbody. Hydraulic information used was generally not taken at the same time as the water quality data used. The availability of only one water quality data site is not sufficient justification to simulate the subsegment using a one reach, one element model. Additional reaches and elements must be used to represent the subsegment and additional data must be obtained in order for these TMDLs to be valid. The recommended maximum limits cited in the LAQUAL User's Manual for element width and length have been grossly exceeded in many of the models. The spreadsheet calibration and projection graphs that were provided do not match the plots produced by the LA-QUAL model. Please explain why they do not match. The LAQUAL graphics for a few elements produces a graph that does not represent the model output. It's an anomaly of the graphics routine. The calibrations are inadequate due to the lack of a hydrologic calibration and the paucity of water quality data. The resulting TMDLs are invalid. LDEQ does not accept these TMDLs.

Response: The TMDLs were based on existing data plus information that could be obtained with available resources. Each model was developed using the most appropriate hydraulic information and water quality data that were available. The level of detail at which each subsegment was modeled was consistent with the amount of available data. Although having only one element in a model causes inaccuracies in the LAQUAL graphics, having only one element in a model does NOT cause errors in the tabular output (which is what the graphs in the reports are based on). Although LDEQ typically collects more data for model calibration than what was available for calibration of these models, EPA considers these model calibrations and the resulting TMDLs to be valid.

2. LDEQ does not consider any of these waters to be impaired due to nutrients or ammonia. LDEQ does not consider Vermilion River Cutoff (060803), Mermentau Coastal Bays and Gulf Water (050901), Charenton Drainage and Navigation Canal (060601), West Cote Blanche Bay (061001), Bayou Des Glaisses Diversion channel (060207), Grand Lake (070701), Gulf Intracoastal Waterway (050702), Lake Peigneur (060909), New Iberia Southern Drainage Canal (060904) and West Atchafalaya Basin Protection Levee Borrow Pit Canal to be impaired by biochemical oxygen-demanding substances. Many of these waters simply have inappropriate

standards and criteria. The resources spent on developing these TMDLs could have been far more effectively and wisely spent on reviewing, approving, and assisting in the development of appropriate standards and criteria for these waters through the UAA process.

Response: TMDLs were developed for these subsegments based on the requirements of Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 and the suspected causes of impairment (organic enrichment/low DO, nutrients, or ammonia) for each subsegment in the EPA Modified Court Ordered 303(d) List.

3. Remove the reference and all references to the unpublished LDEQ document, "Defaults for Uncalibrated Modeling". This is not an acceptable reference and any defaults selected on this basis must be reevaluated and based on acceptable references. Some of the models must be redone because of inappropriately selected defaults. At this time, LDEQ has no plans to revise, complete or publish this document.

Response: The unpublished LDEQ document that is mentioned here was provided to EPA's contractor without any instructions not to use it. The model coefficients listed in that document appear to be reasonable and consistent with values used in other modeling studies in southern Louisiana.

4. The percent reduction of the nonpoint source load must not be reported as an overall average of the individual percent reduction applied to each reach. This approach does not insure that standards will be met in all reaches and will be difficult to implement. In consideration of future implementation plans, LDEQ does not vary the percent reduction required from reach to reach. LDEQ uses a uniform percent reduction within a watershed unless there are unique conditions, such as a general change in landuse, that dictate a further breakdown. These unique conditions must be adequately documented in the report in order to facilitate future implementation plans. Specifying type of land use is helpful in defining nonpoint loading. LDEQ requests a calculation sheet of the NPS reduction percentages and asks that language be added to the report describing the calculation process.

Response: EPA appreciates this comment but believes that an average percent reduction is acceptable. EPA will consider this in future development of TMDLs in Louisiana.

In the lower Mermentau and Vermilion River Basins, much of the nonpoint loading affecting some of these subsegments and adding to their benthic blanket is coming from the tributaries feeding them. Many of the headwater tributaries have recent TMDL's that require dramatic percentage reductions to the nonpoint contributions. By implementing the reductions to nonpoint loads upstream, the current problems in these lower subsegments will be reduced.



Response: EPA recognizes that TMDLs have been developed upstream of several of these subsegments. Implementing upstream reductions in nonpoint loads should require much less reduction of loadings from within these subsegments. The required percent reductions for these subsegments were not intended to be in addition to upstream reductions.

5. The percentage reductions listed were not calculated based on the written procedure described in several TMDLs. These values did not take the MOS into consideration. It is also LDEQ's policy to make a no-man-made load projection run which will estimate the natural background loads. The contractor should include a no-man-made load projection run in each TMDL report.

Response: The percent reductions were calculated by subtracting the projection input value from the calibration input value and then dividing by the calibration input value. This procedure is slightly different than what LDEQ uses but still provides percent reductions that are useful.

6. CBODu and NH<sub>3</sub>-N were estimated from surrogate parameters rather than actual measured data for most of the TMDLs. Based on the measured data from the last two years of LDEQ water quality surveys, LDEQ objects to the correlation of TOC to CBOD and NH<sub>3</sub>-N to TKN, unless these correlations are taken from water quality data on the modeled waterbody. Our studies have shown only a moderate correlation between these two parameters within the same waterbody, however when this correlation was attempted across waterbodies extreme variability was seen and the correlation was not judged valid. It is possible that a combination of surrogates will obtain a better correlation, such as TOC along with color, turbidity, pH, etc. LDEQ is currently researching these options.

Response: EPA agrees that it would be ideal to have data collected from the modeled waterbody for relating TOC to CBOD and NH<sub>3</sub>-N to TKN. However, for these subsegments, there was insufficient data from which these relationships could be developed.

7. LDEQ takes exception to the equating of COD to CBODu in some of the TMDLs. There is no data to support this assumption. No direct correlation has been drawn between these two parameters. The only correlations that have been found are variable and dependant on the type of discharge. LDEQ requests that facilities with only COD limits be removed from the WLA load calculations.

Response: EPA agrees that COD is not an ideal indicator of CBODu. However, EPA believes that most effluents that exert significant COD are likely to exert some oxygen demand in natural waterbodies and therefore the discharges with COD limits should be included in the TMDLs.

8. CBODU and Org-N settling rates were not used. This is not justifiable in areas dominated by agricultural activities and is poor practice for TMDLs on Louisiana waters. The models must be revised to include settling rates.

Response: Without the use of settling rates, all of the pollutant loading remains in the water column where it can consume oxygen. Depending on the model settings for conversion of settled pollutant loading to SOD, the model can be more conservative without settling rates. Other applications of water quality models for TMDLs on southern Louisiana waterbodies have not used settling rates and have been approved by LDEQ.

9. The TMDLs should be for biochemical oxygen-demanding substances instead of DO. DO is an indicator of the impact of biochemical oxygen demanding load, hydrologic modifications, excessive algae blooms, etc.

Response: The TMDLs in Section 5 of each report are already expressed in terms of oxygen demand.

10. Nitrification inhibition option number 2 is valid for Louisiana's waterbodies. Various studies have shown that Louisiana does not have a buildup of NH<sub>3</sub>-N in its waterbodies. If option 1 was needed for a proper calibration then that should be stated as such.

Response: The nitrification inhibition option was set based on algorithms in other widely used water quality models. Option 1 has been used in other water quality modeling applications for TMDLs on southern Louisiana waterbodies that have been approved by LDEQ.

11. A winter projection model was not developed for most of the TMDLs. Winter projection models must be developed to address seasonality requirements of the Clean Water Act. Where point sources have seasonally variable effluent limitations or such seasonal variations are proposed, a winter projection model is required to show that standards are met year-round.

Response: As discussed in Section 4.2 of each report, summer is the most critical season for meeting the year round standard for DO for this subsegment. Therefore, the summer simulation satisfies the seasonality requirements of the Clean Water Act. Performing additional simulations to evaluate permit limits that are seasonal or hydrograph controlled releases was not required for developing these TMDLs and can be done by LDEQ or by permittees.

12. There was no documentation (LA-QUAL plots) to indicate that the model was calibrated to all hydrologic parameters (i.e. flow, width, depth, time of travel, velocity, chloride balance, etc.). Apparently flow balances were performed, however a flow balance is not a hydrologic calibration. Most of the models must be recalibrated with adequate hydrologic data. Calibration plots for all of the hydrologic parameters must be provided in the appendices.

Response: The values of depth, width, and flow in each model were estimated based upon the most appropriate available information. Hydraulic calibration of each model was not possible due to a lack of data.

13. The calibration and projection plots for dissolved oxygen must be provided in the body of the reports. Additional projection plots for CBODU, NH<sub>3</sub>-N, and Org-N must be provided in the appendices.

Response: The placement and number of plots in the draft reports are acceptable.

14. The calibration simulation must be used as the baseline for the sensitivity analysis, not the projection simulation. LDEQ requests that all TMDLs be revised in this regard.

Response: The sensitivity analysis can be developed using either the calibration or the projection as a baseline. EPA will consider this in future development of TMDLs in Louisiana.

15. A list of all point source dischargers must be provided in the body of the reports. Only dischargers with flows that reach the named waterbody should be included in the TMDLs.

In several TMDLs, a default 0.001 MGD flow rate was assigned to dischargers where a flow rate was not available. This practice is unacceptable to LDEQ. This default flow rate is extremely low (LDEQ would typically use 0.005 MGD as a minimum) and could strictly limit these dischargers' allowable permit loads when their permits are renewed. Additional research should be done to determine the facility type and anticipated flow rates of these facilities.

Response: The placement of the list of point source dischargers in the draft reports is acceptable. The dischargers with no flow rate information are believed to have very small flow rates representing a very small portion of the total TMDLs. The actual flow rate for each facility can be determined by LDEQ when the facility's permit is being renewed.

16. LDEQ does not agree with the minor point sources loads being subtracted from the NPS load as was done in several of the TMDLs. The pollutant loads being addressed are non-conservative loads. Many of these dischargers are located on small tributaries to the 303(d) waterbody which have recovered prior to entering into that system. Thus they are not contributing to the pollutant loads in the impaired waterbody. LDEQ's current procedure is to add these loads to the WLA portion of the TMDL.

Response: In the reports for which this comment is applicable, the TMDL calculations have been revised so that these loads are added to the WLA portion of the TMDL (same as LDEQ's procedure). For most of the draft reports, the TMDL calculations already used LDEQ's procedure of adding the minor point sources to the modeled loads.

17. Proper justification must be provided when using a nonpoint source margin of safety value other than the typical LDEQ value of 20%.

Response: The nonpoint margin of safety (MOS) was set to 10% based on other TMDLS on southern Louisiana waterbodies that have either been developed by LDEQ or approved by LDEQ. Eleven TMDL reports from LDEQ's website were reviewed to examine the explicit MOS for nonpoint sources. All 11 of these TMDLS were for oxygen demanding substances in the Mermentau or Vermilion-Teche basins. The explicit MOS for nonpoint sources was set to 20% for 2 reports, 10% for 3 reports, and 0% for 6 reports. Therefore, the value of 10% was considered to be a typical value that did not need special justification.

18. LDEQ has major concerns relating to the use of a one dimensional steady state model in coastal bays, lakes and estuaries. These systems are typically dominated by tides and winds and do not behave like riverine systems. LAQUAL can be used to simulate estuarine systems with riverine characteristics and some tidal influences; however to use it in these applications exceeds the model's recommended input limitations and appears to produce a meaningless output. Also the systems' unique hydrological characteristics do not adapt well to LAQUAL's one-dimensional capabilities. A multi-dimensional model such as WASP should be used for these waters. While a dynamic model would be preferred, a steady-state multi-dimensional model would be acceptable if it adequately addresses tidal influences. LDEQ objects to the use of LAQUAL in determining TMDLS for coastal bays, lakes and estuaries.

Response: A one dimensional steady state model such as LAQUAL was considered to be appropriate for all of these subsegments based on the amount of data that were available. Proper application of a multi-dimensional model or a dynamic model would require much more data and is simply not necessary for these waterbodies. For large, wide waterbodies, WASP will yield the same results as LAQUAL if the configuration of elements and model coefficients are the same between the two models.

19. The report uses the term synoptic survey multiple times. Please describe in detail what area this survey encompassed as well as site locations and what parameters were tested. Also, the raw data from this survey must be included in the appendices as support for the model inputs and calculations.

Response: A description of the synoptic survey and a summary of the data have been added to the appendices for each report in which those data are used.

20. In many of the calibration models the average water quality data from several LDEQ stations were used. It has been LDEQ's experience that a better calibration can be accomplished by using a single day's water quality and flow data. The additional daily values could then be used to perform multiple verifications of the model parameters before proceeding to the projection

stage. The flow data should be collected at the same time as the water quality data in order for the model to be valid.

Response: The models were calibrated to averages over multiple sampling events to minimize the effects of any single field measurement that might be of questionable quality or indicative of conditions that may have lasted only a very short time. For large systems with long residence times, using only a single snapshot of water quality data is often not representative of steady state conditions for that system.

21. Grammatical errors and misspelled words were found in these reports.

Response: The reports have been reviewed for grammar and spelling.

22. There does not appear to be any significant anthropogenic source of nutrients from agriculture, silviculture, aquaculture or urban runoff in many of these subsegments. Therefore, any occurrence of low DO is almost certainly natural. As a result, a UAA for the area is necessary to reset the DO standard. A TMDL is unwarranted for these subsegments, and LDEQ takes exception to EPA generating TMDLs which are impossible to implement.

Response: EPA is required to generate these TMDLs based on the Modified Court Ordered 303(d) List and the requirements of Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7.

23. LDEQ's nutrient standard is based on total phosphorus (TP) and total nitrogen (TN), not total inorganic nitrogen (TIN). Since phosphorus is not the limiting constituent in Louisiana, the nutrient allocations must be in terms of TN and only TN.

Response: LDEQ's nutrient standard (LAC 33:IX.1113.B.8) does not specify that nitrogen to phosphorus ratios should be based on total nitrogen. However, EPA will consider this in future development of TMDLs in Louisiana.

In the coastal areas, the nitrogen to phosphorus ratio used was based on freshwater streams and is not applicable to brackish Gulf waters. LDEQ takes exception to the calculation of a TMDL based on TN/TP ratios derived from waterbodies other than the modeled waterbody. It is LDEQ's experience that the natural allowable TN/TP ratio is waterbody-specific and can vary dramatically between streams.

Response: EPA agrees that it would be ideal to have a large database of nitrogen to phosphorus ratios for each waterbody. However, because these subsegments have only limited nutrient data, the previously developed nitrogen to phosphorus ratio that was used in the draft reports is considered acceptable.

LDEQ has not adopted the EPA recommended ammonia criteria (1999) and takes exception to its use in this TMDL. In general, LDEQ does not accept EPA's use of national guidance for TMDL endpoints. The nationally recommended criteria do not consider regional or site-specific conditions or species and may be inappropriately over protective or under protective. No ammonia nitrogen toxicity has been demonstrated or documented in any of the waterbodies in these TMDLs. The general criteria (in particular, LAC 33:IX.1113.B.5) require state waters be free from the effects of toxic substances.

Response: Ammonia TMDLs were developed for two subsegments based on the requirements of Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 and the fact that the Modified Court Ordered 303(d) List included ammonia as a suspected cause of impairment for those two subsegments. National guidance for ammonia toxicity was used in the absence of any numerical state water quality standards for ammonia.

24. The implicit margin-of-safety must not be quantified.

Response: The text of the reports has been revised to eliminate any quantification of the implicit margin of safety.

25. EXECUTIVE SUMMARIES: Add summary tables of the WLAs, LAs, and TMDLs showing the allocations and margins of safety.

Response: The summary tables of the WLAs, LAs, and TMDLs can be easily found in Section 5 of each report and do not need to be repeated in the executive summary.

26. Temperature Correction of Kinetics: A temperature correction factor was set for reaeration. It is LDEQ's standard practice to allow LAQUAL to calculate this factor. There is more guidance on this in the LAQUAL User's Manual.

Response: The temperature correction factor was reaeration was set to the value of 1.024 based on guidance in Section 3.3.8 of the LTP.

27. Water Quality Kinetics: The Louisiana reaeration equation was used on reaches that are outside the maximum depth that it was designed for. A more appropriate reaeration equation must be selected.

Response: The Louisiana equation yielded reaeration coefficients that appeared more reasonable than coefficients from other equations.

28. Water Quality standards and designated uses tables did not include the BAC (bacterial criteria) values.

Response: The water quality standards for bacteria are not relevant for these TMDLs.

29. The statement was made in the Initial Conditions paragraphs in several of the reports that temperature was specified because the temperature was not being simulated. The section then states, "For constituents not being simulated, the initial concentrations were set to zero ...". Initial conditions provide a starting point for the iterative solution of modeled constituents. They also provide values for constituents that are needed as input but are not being simulated.

Response: EPA appreciates this comment.

30. Several reports describe the benthic ammonia source rate as a calibration parameter; however a review of the data type 13 calibration input section indicates a value of zero for this parameter, in all reaches.

Response: The benthic ammonia source rate was used as a calibration parameter; the value of that parameter that provided the best fit between predicted and observed values was zero.

31. Calibration, and Projection, Data type 27: A salinity value was set to zero in the boundary conditions for both the calibration and the projection models in several of the TMDLs. With this value set to zero the model will automatically adjust the values of the lowest reach's elements to the value set in the boundary conditions. Since most of the models were one-reach, one-element models, the model automatically set the element salinity to zero, thus calculating an inaccurate value for the DO saturation.

Response: The only models where salinity was set to zero in the downstream boundary conditions were those models where salinity was not considered high enough to have a significant impact on DO saturation.

32. It is not LDEQ's standard procedure to use a zero headwater flow. You may not have input a headwater flow, but the model did. Without a headwater flow the model would have crashed and not run. The model's programming allows for a 0.0000001 cms flow rate when the modeler has not input a headwater flow.

Response: Only two simulations (calibrations for Spanish Lake and Big Constance Lake) used a zero headwater flow. For all practical purposes, 0.0000001 m3/sec is the same as zero flow.

33. Hydraulics and Dispersion: The use of constant widths and depths requires proper justification.

Response: The widths and depths were justified in Section 3 of each report.

34. Several reports state that algae were not simulated because algae did not appear to have significant impacts. What was the evidence for this statement? Did the contractor have any Chlorophyll a measurements?

Response: This statement was based on general knowledge of the Mermentau and Vermilion-Teche basins as well as a limited amount of diurnal DO data collected in these basins.

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#### SPECIFIC COMMENTS FROM LDEQ FOR BAYOU TIGRE:

1. See General Comments.
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#### GENERAL COMMENTS FROM LOUISIANA STATE UNIVERSITY (LSU) AG CENTER (some of these comments may not apply to this report):

Through this letter the Louisiana State University AgCenter would like to submit official comments on TMDLs for dissolved oxygen and nutrients associated allocations for waterbodies in:

- Vermilion River Cutoff
- Bayou Chene
- Bayou Petite Anse
- Bayou Tigre
- Big Constance Lake and Mermentau Coastal Bays and Gulf Water
- Charenton Drainage and Navigation Canal and West Cote Blanche Bay
- Chatlin Lake Canal/Bayou Du Lac and Bayou Des Glaises Diversion Channel
- Dugas Canal
- Franklin Canal
- Freshwater Bayou Canal
- Irish Ditch/Big Bayou
- Lake Arthur, Grand Lake, and Gulf Intracoastal Waterway
- Lake Peigneur
- New Iberia Southern Drainage Canal
- Spanish Lake
- Tete Bayou
- Bayou Carron
- West Atchafalaya Basin Protection Levee Borrow Pit Canal

The number of different TMDLs sent out for comment at the same time may overwhelm the public's ability to comment. With only 30 days to prepare and submit comments it is impossible for a qualified faculty member to review the supporting data in depth and attend to his(her) official responsibilities. I realize that



the agency is under time constraints on completing these, but I earnestly request that more time per proposed TMDL be given in the future.

We must make several other general comments and objections that apply to most of the proposed TMDLs. In many cases the data used to calibrate the models for the stream segments was collected in the fall of 2000 near the end of a three year drought. Historic low flows were often commented on in the text of the TMDL. Low flows result in a biased estimate of the natural ability of the stream to reaerate and cleanse itself of pollutants. Low flows also enable the benthic blanket to accumulate and remain in place undisturbed causing overstatement of the benthic oxygen demand and the SOD which were in many cases the primary oxygen demand loads in the stream. While it is true that the high flows that come from storm events carry more organic and sediment loads into the stream, the high flow rates also scour material from the bottoms and move it on to a final deposit at the stream terminus. It was thus that most of Louisiana and all of our coastal areas were built. Prolonged drought conditions do not allow this natural cleansing to occur. Thus it is our belief that the part of the oxygen demand load attributed to benthic and sediments is overstated and that new data must be collected during normal rainfall conditions and the models re-calibrated.

Response: The Louisiana water quality standards are applicable during all flow conditions greater than the 7Q10. Because 7Q10 flow is frequently the most critical condition for maintaining the DO standard, it is desirable to collect field data for model calibration during times when the hydrology is as close as possible to 7Q10 conditions. It is believed that the flow conditions for these waterbodies may have been near 7Q10 conditions, but probably not lower than 7Q10 flows. Therefore, the summer-fall 1998 data is desirable for model calibration.

In far too many of the proposed TMDLs the phrase *"an intensive field survey was not conducted for the study area due to schedule and budget limitations"* was found. If municipalities, agriculture, and business entities are to be asked to make large commitments of funds, time and effort to resolve our water quality problems they deserve to have the benefit of a serious study of the problem. We request that all of the proposed TMDLs that contain this statement have this problem corrected and that TMDLs be prepared based on complete studies.

Response: There is no requirement for collecting a certain amount of data to make a TMDL valid. If additional data are collected in the future by LDEQ, other agencies, or local stakeholders, then those data can be evaluated at the time and the implementation of the TMDL can be altered as necessary. As outlined in the 1991 EPA document titled "Guidance for Water Quality-Based Decisions: The TMDL Process", developing and implementing TMDLs is a process and not a one-time event.

In several of the proposed TMDLs data was used that is 9 or 10 years old from studies on point source discharges. While the data is probably high quality it assumes that no change in the plant or its load have occurred in the last decade. This assumption may not be defensible. In the TMDLs where a treatment plant was included in the model the margin of error was calculated by using 125% of the design capacity. This assumes a plant will perform at the same level when it is operated in excess of its design load. This assumption is also questionable.

Response: For several subsegments, old data sets were used for calibration because they provided more extensive data than newer data sets. However, all of the projection runs simulated point source discharges based on the most recent information available. Simulating point source discharges at 125% of design flow is simply a way of incorporating an explicit margin of safety and does not assume that the facility can actually treat that much wastewater.

The standard for dissolved oxygen (DO) was held at 5 mg/L in some streams on a year round basis, even if it received or discharged into a stream with 5 mg/L winter and 2 or 3 mg/l summer standards. Other streams had a year DO oxygen standard of 4 mg/L. We strongly suggest that a review be made of the DO standards for all of the streams in south Louisiana that are shallow, sluggish, and subject to tidal influence and that uniform standards be set. In view of the remarks that achieving a DO of 5 mg/L was impossible in some of the streams that had little loading from human activities, we believe that the summer standard of 2 mg/L is much more applicable to these streams.

Response: The TMDLs are required to be developed for the existing DO standard, which is 5 mg/L year round for many of these subsegments. If the DO standard is revised in the future for any of these subsegments, the TMDL and implementation can be altered as necessary as part of the TMDL process.

Many of these TMDLs were drafted by an out of state contractor and do not appear to be as well researched as those drafted by LDEQ. Very little data was included in the contractor drafted TMDLs summaries as compared to the ones prepared by or in conjunction with LDEQ. Additionally, the bulk of the text appeared to be standard wording in all documents with short relevant inserts. We would request that if outside contractors be used in future TMDL assessments that they be held to the same standard of information inclusion that LDEQ provides. Stream diagrams and maps are often needed when reviewing descriptive text on stream location, tributary insert, and exact location.

Response: These TMDLs contain all the required components of a TMDL and the level of detail is considered acceptable. Because these TMDLs could not be funded at the same level as most of LDEQ's DO TMDLs, the analysis and documentation was not as extensive as most of LDEQ's DO TMDLs. However, some of the information that was mentioned in the comment (stream diagrams and maps) was included in the reports, but they were placed in the appendices (which were available from EPA upon request).

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#### SPECIFIC COMMENTS FROM LSU AG CENTER FOR BAYOU TIGRE:

Decreasing SOD and increasing reaeration appear to be key factors in solving the low DO content in this stream segment. Since the data for this determination was collected in September 2000 after a prolonged drought, re-evaluation after a period of normal rainfall may reduce the NPS load reduction requested of 40-60% for the upper reaches to an attainable level and may eliminate the need for the indicated upgrade of the Erath wastewater treatment plant.

Response: As discussed in a response above, using data collected during critical conditions (i.e., flows near 7Q10) is desirable for model calibration. If a treatment upgrade for the Town of Erath WWTP is not necessary for flows and temperatures that occur most of the time, the Town may wish to pursue alternative discharge strategies (e.g., hydrograph controlled releases, land application during critical periods, etc.).